dangers and drawbacks incidental to it, but not to forget the limitless possibilities for good which it offers," and further, "almost without a struggle is established the possibility of a complete national system of technical instruction." It is for this that we have reason to be thankful to the Government: it has placed the instrument in our hands, and it is for us now to use it efficiently.

CAMBRIDGE MATHEMATICS.

A History of the Study of Mathematics at Cambridge. By W. W. Rouse Ball. (Cambridge: University Press, 1889.)

AUGUSTUS DE MORGAN, writing more than fifty years ago, says that "the literary history of this country requires separate and minute accounts of the rise of science in Oxford, in Cambridge, and in the north of England, which should severally end (if it might be no later) with Wallis, Newton, and Thomas Simpson."[1] To what extent this long-felt want has been supplied by other publications, we cannot tell; but we know of none readily accessible to the student of mathematical history, and therefore hail with satisfaction the appearance of the small octavo volume which is the subject of our review.

What we should call the study of mathematics at Cambridge is of comparatively recent origin: for, although Seth Ward "brought mathematical learning into vogue in the University, . . . where he lectured his pupils in Master Oughtred's 'Clavis,'"[2] the first Mathematical Professor there was Isaac Barrow (Ward's junior by about twelve years), and the lectures of his illustrious successor were so ill attended that M. Bertrand says: "Il professa trente ans à Cambridge sans y former un disciple digne de lui; la salle du cours restait souvent déserte le jour de sa leçon, et Newton retournait alors tranquillement à ses travaux."[3] Oughtred, whose "Clavis Mathematica" was published in 1631, did not reside long at Cambridge: his secluded life is thus described by our author:—

> "Although living in a country vicarage he kept up his interest in mathematics. Equally with Briggs he received one of the earliest copies of Napier's 'Canon' on logarithms, and was at once impressed with the great value of the discovery. Somewhat later in life he wrote two or three works. He always gave gratuitous instruction to any who came to him, provided they would learn to 'write a decent hand.' He complained bitterly of the penury of his wife, who always took away his candle after supper, 'whereby many a good motion was lost and many a problem unsolved'; and one of his pupils who secretly gave him a box of candles earned his warmest esteem. He is described as a little man, with black hair, black eyes, and a great deal of spirit. Like nearly all the mathematicians of the time, he was somewhat of an astrologer and alchemist. He died at his vicarage of Albury in Surrey on June 30, 1660."[4]

Mr. Ball leaves us in doubt as to the nature of the "two or three works" written "somewhat later in life" by Oughtred. Fortunately we are able to supply this omission from an old book[5] on our shelves, which says that

> "Lord Napier, in 1614, publishing at Edinburgh his 'Mirifici logarithmorum canonis descriptio, ejusque usus in utraque trigonometria, &c.,' it presently fell into the hands of Mr. Briggs, then geometry-reader of Gresham College in London; and that gentleman, forming a design to perfect Lord Napier's plan, consulted Oughtred upon it; who probably wrote his 'Treatise of Trigonometry' about the same time, since it is evidently formed upon the plan of Lord Napier's 'Canon.' In prosecuting the same subject, he invented, not many years after, an instrument, called 'The Circles of Proportion.' . . . All such questions in arithmetic, geometry, astronomy, and navigation, as depended upon simple and compound proportion, might be wrought by it; and it was the first sliding rule that was projected for those uses, as well as that of gauging."

Authorities differ as to the day of Oughtred's death: thus the "Penny Cyclopædia" makes it happen on "Jan. 30th" (a misprint, probably, for the same day of June); in the article just quoted it is "about the beginning of May"; and in the historical introduction to Hammond's "Algebra"[6] we read that "he lived to the Age of Fourscore and Seven, and died then of Joy, on May 1, 1660, at hearing the House of Commons had voted the King's Return."

One circumstance compels us to reject this account: we cannot understand how Oughtred, living in the neighbourhood of Guildford, could know what took place in Parliament, on May 1, before the next day. But the mere fact of his death being currently attributed to such a cause illustrates so well the intense political excitement of the times in which he lived that it ought not to be passed over in silence. It is of more value than many boxes of candles.

From the time of Newton down to the beginning of the present century, mathematics (though diligently studied) made very little progress, either at Cambridge or in other parts of England. In Cambridge this was due to the excessive reverence paid to authority; at first by all, and afterwards by those "senior members of the senate, who regarded any attempt at innovation as a sin against the memory of Newton,"[7] and who were the worthy successors of the Cambridge dons described by Pope, in 1742, as

> "A hundred head of Aristotle's friends."[8]

We may be mistaken, but we strongly suspect that one of them was William Farish (b. 1759, d. 1837), whose memory is embalmed in the following extract:—

> "He is celebrated in the domestic history of the University for having reduced the practice of using Latin as the official language of the schools and the University to a complete farce. On one occasion, when the audience in the schools was unexpectedly increased by the presence of a dog, he stopped the discussion to give the peremptory order, *Verte canem ex*. At another time one of the candidates had forgotten to put on the bands which are

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[1] "Notices of English Mathematical and Astronomical Writers between the Norman Conquest and the Year 1600." This important article appeared anonymously in the Companion to the Almanac for 1837, but was undoubtedly written by De Morgan, and in fact was claimed by him six years afterwards.

[2] Ball, p. 37. In referring to the work before us, both here and subsequently, for brevity we cite only the author's name and the number of the page.

[3] "Les Fondateurs de l'Astronomie Moderne" (8vo, Paris, n.d.) p. 303.

[4] Ball, p. 30.

[5] As no edition of this work is mentioned by De Morgan in his "References for the History of the Mathematical Sciences," we give its title in full, as follows: "A New and General Biographical Dictionary; containing an Historical and Critical Account of the Lives and Writings of the Most Eminent Persons in every Nation; particularly the British and Irish; from the Earliest Accounts of Time to the present Period. Wherein Their remarkable Actions and Sufferings, Their Virtues, Parts, and Learning, are Accurately Displayed. With a Catalogue of their Literary Productions. A New Edition, in Twelve Volumes, greatly enlarged and improved" (8vo, London, 1784).

[6] The third edition, 8vo. London, 1764.

[7] Ball, p. 117.

[8] "Dunciad," iv. 192. A note to this verse reads thus:—"The Philosophy of *Aristotle* had suffered a long disgrace in this learned University: being first expelled by the *Cartesian*, which, in its turn gave place to the *Newtonian*. But it had all this while some faithful followers in secret, who never bowed the knee to *Baal*, nor acknowledged any strange God in Philosophy."

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still worn on certain ceremonial occasions. Farish, who was presiding, said, *Domine opponentium tertie, non habes quod debes. Ubi sunt tui.* . . . (with a long pause) *Anglice bands?* To whom with commendable promptness the undergraduate replied, *Dignissime domine moderator, sunt in meo* (*Anglice*) *pocket.* Another piece of scholastic Latin quoted by Wordsworth is, *Domine opponens non video vim tuum argumentum.*" [9]

In the last sentence "his scholastic Latin" would read better than "scholastic Latin": perhaps, however, this alteration could not be made without violating historic truth; in which case it might be difficult (but we hope not impossible) to substitute some other Latin sentence belonging undoubtedly to Farish, and anything like as good as his exquisite "*Verte canem ex.*" It is recorded, to the credit of Farish, that he resided and taught; a rare instance of virtue in a Professor of that period. Strange abuses were prevalent in his time; among them the practice of "huddling" the disputations in the schools may be mentioned.

> "By the Elizabethan code every student before being admitted to a degree had to swear that he had performed all the statutable exercises. The additional number thus required to be performed were kept by what was called *huddling*. To do this a regent took the moderator's seat, one candidate then occupied the respondent's rostrum, and another the opponent's. *Recte statuit Newtonus*, said the respondent. *Recte non statuit Newtonus*, replied the opponent. This was a disputation, and it was repeated a sufficient number of times to count for as many disputations. The men then changed places, and the same process was repeated, each maintaining the contrary of his first assertion—an admirable practice, as De Morgan observed, for those who were going to enter political life. Jebb asserts that in his time (1772) a candidate in this way could, as a respondent, read two theses, propound six questions, and answer sixteen arguments against them, all in five minutes."

The above is extracted from the chapter devoted to the exercises in the schools. This and the one on the mathematical tripos (ix. and x.) are the two best chapters in the book, and contain a large mass of interesting matter; but since the substance of both is reprinted from the author's "Origin and History of the Mathematical Tripos" (Cambridge, 1880), with which many of our readers are doubtless acquainted, we refrain from making any further quotations from either. We need only say that together with chapter viii. (under the heading "The Organization and Subjects of Education") and chapter xi. ("Outlines of the History of the University") they constitute the second of the two well-defined portions into which the present work is divided, and give a clear though succinct account of the history of Cambridge and of the principal object of study there, from the earliest times to the date of the repeal of the Elizabethan statutes (1858), with which the history is made to terminate. The first seven chapters, which (see the preface) "are devoted to an enumeration of the more eminent Cambridge mathematicians, arranged chronologically," embrace the same period of time. Their style is somewhat similar to that of the author's "History of Mathematics" published last year, but is still more concise. In them, with the assistance afforded by the introductory paragraphs prefixed to each, we are enabled to trace the rise of mathematical science from the earliest times to the death of Newton (i. to iv.), and its subsequent decadence in Cambridge (v. and vi.), until we come to chapter vii., which is mainly occupied with those mathematical reforms (initiated by Robert Woodhouse, and carried out by Peacock, Herschel, Babbage, and others) which inaugurated the great modern revival of learning in England, spoken of by Mr. Ball in his concluding paragraph as the "new renaissance." The first portion of the work terminates with this chapter, which also contains notices of some of the more prominent mathematicians who graduated at Cambridge since the time of the above-mentioned reformers, but not later than the Tripos of 1859. Except in the ninth and tenth chapters, the style is too condensed, and conciseness is sometimes attained by the suppression of interesting facts; but this is not an unmixed evil, since the cost of publication is thereby kept down, and we have every reason to believe that those who are content to pay a moderate price for a general view of the subject will find in this little volume a very useful compendium of Cambridge mathematical history.

We ought to add that, in its externals, the book is all that most attracts the fastidious purchaser. It is neatly bound, in general correctly printed, in clear type, and on good paper. The table of contents and index are also good.[10]

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[9] Ball, p. 106.

[10] In this note we append a few disjointed remarks for the sake of pointing out certain trivial *errata*, and small emendations, or what we believe to be such:—

P. 17, "belated traveller." A man who had travelled no farther than from St. James's Park to Whitefriars (see "The Fortunes of Nigel," ch. xvi. and xvii.) and who had remained in sanctuary there for some days, can hardly be called a belated traveller because he asks for "a book—any sort of book—to pass away the night withal," and we can discover no other reason. The passage we allude to occurs in ch. xxiv. of Scott's novel, and in the version from which we quote runs thus:—"*She heard with interest Lord Glenvarloch's request to have a book—any sort of book—to pass away the night withal, and* returned for answer, that she knew of no other books in the house than her young mistress's (*as she always denominated Mistress Martha Trapbois*) Bible, which the owner would not lend; and her Master's Whetstone of Witte, *being the second part of Arithmetic*, by Robert Record, *with the Cossike Practice and Rule of Equation; which promising volume Nigel declined to borrow.*" This is quoted both by De Morgan and Mr. Ball, of whom the latter omits the italicized words, and the former those only that are also underlined. Both of them omit the comma between "answer" and "that"; and both spell "Bible" with a small "b," "Master's" with a small "m," and "Record" with a final "e." From this we infer that both of them quoted from a version of Scott differing from the one on our shelves in the above particulars, unless Mr. Ball copied his quotation from De Morgan's. The fact that De Morgan makes no allusion to a "belated traveller" seems to favour the former theory. Our author deals with Recorde just as he has done with Scott: he takes a passage from him, gives certain portions of it, and modernizes the spelling (see the quotations from Recorde on pp. 16–18, and compare them with those given in the article by De Morgan, referred to in note [1], which contains all of them and is easily procurable). The ghost of an old author has a right to complain of the alteration of a single letter in his work, and to say "Interpretation will misquote our *b*ooks" (Hen. IV., Part I., act v., sc. 2). There! we have committed the very offence we felt called upon to condemn, and have changed Shakespeare's "l" into a "b."

P. 31. For "*circle of proportion*" read "*circles of proportion.*"

P. 41. The first volume of Marie's "Histoire des Sciences mathématiques" was published in 1883: this date is changed into 1833 by an obvious misprint.

P. 72. The correct title of Dr. Sloman's work (which lies open before us as we write) is, "The claim" (not claims) "of Leibnitz to the invention of the differential calculus."

P. 91. Smith's "Compleat System of Opticks" was published in 1738 (not 1728). An advertisement dated "*London*, Apr. 25, 1738," speaks of it as "Printing at *Cambridge* in Quarto, and will be published by the latter end of *May* or the beginning of *June*" (we quote *literally*).

P. 93. It is not easy to identify books whose titles are not given, but we know of no text-book by Humphry Ditton "on the infinitesimal calculus" of an earlier date than 1706, when his "Institution of Fluxions" was published. We therefore conclude that the date 1704 must be a misprint for 1706, and shall continue to think so until we actually see an edition dated 1704.

On this page also, for "Robert Smith (1728)" read "Robert Smith (1738)."

P. 257. In the index, insert the reference "Commercium Epistolicum, 72"; for "Creswell" read "Cresswell;" and in the third line of the references to De Morgan, *dele* 180.

We have given the above list in compliance with the words, "I shall thankfully accept notices of additions or corrections which may occur to any of my readers," with which Mr. Ball's preface terminates.

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